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In Situ Mars Ozone Detector

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We propose sending a balloon-borne UV photometer sensor package to measure atmospheric ozone on Mars, and this package could be a Discovery Program sensor candidate. Past measurements of ozone on Mars are highly uncertain, perhaps a factor of 3 or so uncertain (Lindner, 1993), due primarily to interference and masking by cloud and dust. In-situ balloon measurements would avoid these problems, and would provide 'ground truth' which remote sensing techniques cannot. We have explored this approach to measure ozone abundance in the terrestrial stratosphere with a balloon-borne UV absorption photometer (described in detail in Weinstock et al., 1986). Atmospheric pressures and temperatures and ozone concentrations near the surface of Mars are similar to those in the terrestrial stratosphere.

In brief, the instrument uses 245-nm radiation from a low-pressure mercury discharge lamp in a 40-pass white cell (1200-cm path length). The instrument has measured terrestrial stratospheric ozone with better than 3% precision and 5% accuracy. The instrument is small (approx. 30cm cubed), lightweight (approx. 20 kg), self-scrubbing (i.e., self-calibrating), and has in-flight diagnostics and a low data rate. This balloon-borne photometer is expected to be able to measure ozone throughout the polar winter region (poleward of 40° latitude) within the lower 20 km of the atmosphere but possibly not at equatorial latitudes where O_3 concentrations are extremely low (10^9 cm^{-3}), although slight improvements may allow for measurement of these low concentrations as well.

The objectives for this instrument are to observe O_3 variability with cloud and dust amount, to measure the altitude dependence of O_3, and to measure diurnal fluctuations in O_3. There are no measurements to date of any of these variations. The abundance of ozone during the great dust storms on Mars is totally unknown due to the inability to see through the dust. The possibility of heterogeneous chemistry of ozone with airborne dust and cloud on Mars is the most active topic in Mars aeronomy today, and the question can only be settled through an in situ study such as we propose. The dependence of ozone on altitude has never been measured, only the column abundance. An improved understanding of the altitude dependence of ozone would also determine the degree of vertical atmospheric transport. Because the instrument proposed here contains a lamp, ozone could be measured throughout the day/night cycle. Ozone in polar night has never been measured, and measurements here would greatly increase our understanding of heterogeneous chemistry and atmospheric transport.

Hence, in-situ ozone measurements would significantly improve our understanding of Mars atmospheric chemistry and composition and the interaction of atmospheric chemistry with atmospheric radiation and dynamics. Much interest has been generated over the past 5 years for a Mars Aeronomy Mission. This is a low cost alternative which in many respects will learn more information. This mission would complement a proposed Japanese mission to study the chemistry of the martian upper atmosphere (Tsuruda, 1991).

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